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VOLUME XXXIX OCTOBER, 1940 NUMBER 7

THE ALUMINUM INDUSTRY

WARREN STRAIN

State Teachers College, Slippery Rock, Pennsylvania

One of the most popular metals in modern use is aluminum and it is doubtful if any other metal can be obtained in as many diversified forms. Its basic commodities include those fabricated by every known metal-working process while its application ranges from beads and ladies' mesh bags to dump trucks of twenty-five tons capacity; from collapsible tubes for toothpaste to railroad cars and trains; from sheets of foil less than 0.005 inch thick for wrapping candy to bridge floors carrying tremendous loads. Unlike most popular metals, aluminum has only recently entered the industrial world on a commercial scale.

Altho aluminum was first isolated as early as 1825 by a Danish chemist, Hans Christian Oersted, little more than one hundred tons had been produced in the whole world prior to 1886 and this at a tremendous cost. Aluminum was considered a precious metal and limited to the trade of jewelers. It is reported that Napoleon III at a state dinner had the most distinguished guests served on aluminum plates while the ordinary guests were merely served on plates of pure gold. This story seems incredible today when aluminum is such a common part of our daily life. When we realize that eight per cent of the earth's crust is composed of aluminum, a higher percentage than any other metal, it is even more incredible. But the secret lies in the fact that aluminum is found nowhere in the earth in its metallic state and it was not until 1886 that a process was discovered by Charles Hall, a young graduate of Oberlin College, whereby the metal could easily and cheaply be obtained from the ore.

Even after the process was discovered, the problem of getting financial backing was a question which threatened the industry. Finally Hall found financial support and coöperation from a small group of Pittsburghers who formed the Pittsburgh Reduction Com-

pany which later became the Aluminum Company of America. They soon were producing about fifty pounds of aluminum per day but the problem of finding a market for "such a large quantity" was a serious one. Plants were not equipped to handle it and industrial-

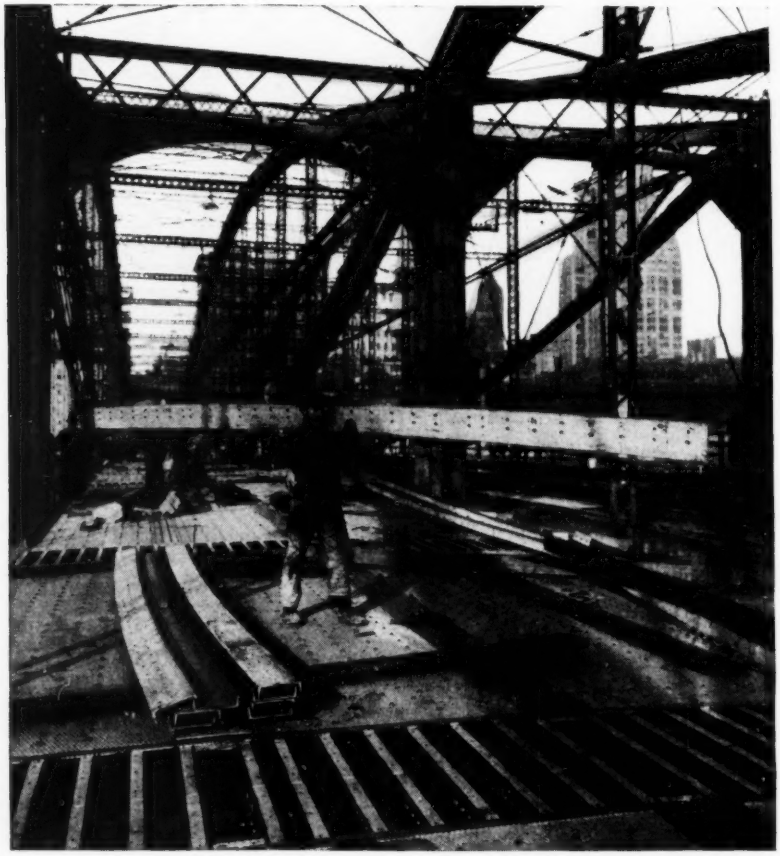

Fig. 1. The Smithfield Street Bridge, Pittsburgh, was reconstructed in 1933 with a strong aluminum alloy floor system, making possible the elimination of 750 tons dead weight. The 8-inch aluminum cambered channel the man is carrying is 21 feet long. (Courtesy of Aluminum Company of America)

ists were not inclined to make over their plants to try the new metal. Thus of necessity the Pittsburgh Reduction Company was forced into fabrication of the aluminum. They began by making kitchen utensils. It has been aptly said, "The aluminum industry was virtually born in a teakettle."

The characteristics which make aluminum especially desirable

are (1) light weight, (2) resistance to corrosion, (3) ease with which it can be worked, (4) good electrical and heat conductivity, (5) non-toxic properties, and (6) attractive appearance. A few illustrations will show the importance of the first quality (Fig. 1). Forty-eight pounds of aluminum cable will carry the same amount of electricity as one hundred pounds of copper. This means a great saving in the construction of power lines, since the distance between the steel towers can be much greater when the light aluminum cables are used. In the past refrigerator rooms on ships have been insulated chiefly with cork or magnesia. This is largely being replaced by crumpled aluminum foil. Roughly, cork weighs about ten pounds per cubic foot and magnesia weighs eighteen pounds, while crumpled aluminum foil with equal insulating value weighs only three ounces per cubic foot. It is estimated that the saving of fifty tons can be effected by using aluminum paint instead of the regular lead paint for a single ocean cruiser. Many other illustrations could be given to emphasize the importance of the quality of lightness.

Aluminum finds its major use in the transportation industries. Approximately one-third of the total production is so used. Manufacturers of kitchen utensils consume about one-sixth of the aluminum while much of the remainder is made into electrical transmission cables, electrical appliances, and in buildings.

The Bauxite

The ore from which aluminum is made is bauxite. It is derived from the weathering of syenite, an igneous rock similar to granite but with a lower silica content. While all clay deposits have aluminum as their basic property, the metal is more easily obtained from bauxite and until this supply is exhausted, clay will be little used. There seems to be no immediate danger of exhaustion, since the world's present known reserve is estimated to be sufficient to last, at the present rate of consumption, for at least one thousand years, and after that much high grade clay would be available.

While bauxite deposits are widespread, there are, however, five regions of major production. The most important is southern Europe which includes France, Italy, Yugoslavia, Hungary, and Rumania. These countries normally provide more than half (54 per cent) of the world's production. The second region is northern South America, especially the Guianas which account for about twenty per cent of the total world output. The United States, the third important producing region, accounts for about twelve per

Fig. 2. An open pit bauxite mine near Bauxite, Arkansas.
(Courtesy of Aluminum Company of America)

cent of the bauxite, while southeastern Asia and central Russia each produce about half as much. All the other countries supply less than two per cent of the world's output.

Bauxite production in the United States is limited to three producing areas, namely (1) Arkansas, (2) Georgia, and (3) Alabama. Of these, Arkansas is by far the most important and produces be-

tween ninety and ninety-five per cent of the bauxite mined in this country. Here the operations are concentrated in two counties near the center of the state. The bauxite is obtained from both open pits and tunnel mines (Fig. 2). After the ore has been mined it is taken to a calcining plant nearby, where it is crushed, washed to remove the less valuable clays, and dried in long rotating kilns to remove the excess moisture and thereby reduce the tonnage upon which freight must be paid. Natural gas from the nearby Louisiana fields is used for fuel. One of the most important calcining centers is the village of Bauxite, near Little Rock.

About half of the bauxite thus prepared is shipped by rail to East St. Louis, Illinois, where it is further processed for use in the aluminum industry. The other half of the Arkansas ore and all of the Alabama and Georgia bauxite is used in the abrasive, chemical, oil refining, and refractory industries. Ores with a relatively high iron content are especially valuable for the manufacture of artificial corundum, emery, and other abrasives, while ores with low iron and low silica contents are especially suitable for the chemical industries.

Domestic ores provide only about twenty-five per cent to thirty-five per cent of our local needs. The remainder is supplied almost wholly by imports from Dutch and British Guiana.[1] This imported ore enters the United States chiefly thru the ports of Mobile, Alabama, and Westwego, Louisiana, the latter receiving about fifty-five per cent of the imports. From Westwego, and to some extent from Mobile, the ore is taken by train to the East St. Louis plant for further processing.

Preparation of Alumina

Before the bauxite can be used in the aluminum industry it must be refined and made into aluminum oxide.[2] This is done by simply stirring the finely ground bauxite into a hot solution of caustic soda. The caustic soda dissolves out the alumina without any effect upon the impurities which remain in the solid form. The impurities are then removed from the solution in large filter presses and dis-

[1] In 1938 Dutch Guiana provided 85%, British Guiana supplied 13%, and Greece furnished 2% of our total import of bauxite. The ore from Greece was used almost wholly in the manufacturing of quick setting cement.

[2] The term aluminum oxide is synonymous with alumina but these terms must not be confused with aluminum, the metal. Alumina is the purified ore from which aluminum is made and resembles common baking soda in appearance.

carded. As the solution cools, the refined bauxite is precipitated. It is then washed to free it of the caustic soda after which the chemically combined water is driven off by heating it white hot in large rotating kilns. Failure to remove the water would cause disturbances in later processes. The alumina thus obtained is ready for shipment to a reduction plant where it will be converted into metallic aluminum.

Prior to 1936 the only plant in North America producing alumina was at East St. Louis. The location of such a factory is very important since it requires two tons of bauxite, two tons of coal, and about two hundred pounds of soda ash to produce one ton of alumina. In addition, large quantities of water low in lime and magnesium must be available. East St. Louis is very favorably located since (1) it is adjacent to the Eastern Interior Coal Fields, (2) it is near the Arkansas bauxite mines, (3) soda ash may be obtained reasonably, (4) there is a large supply of desirable industrial water available, and (5) there is an adequate labor supply. Furthermore, large deposits of fluorspar are found at Rosiclair, Illinois, nearby. The fluorspar is used to neutralize any of the caustic soda which may remain in the alumina.

In 1936 the Canadian plant at Arvida, in the Province of Quebec, began operations making Canada no longer dependent upon alumina from East St. Louis. Two years later another alumina plant began operations at Mobile, Alabama. This plant depends entirely on ore imported from Dutch Guiana. The reason for the location at tidewater is of course obvious. Fuel is supplied from the natural gas fields of Louisiana. At present practically all of the alumina from the Mobile plant goes up the Great Valley to Alcoa, Tennessee, where it is reduced to metallic aluminum.

Location of Reduction Plants

The most important single factor in locating a reduction plant is the proximity to cheap and abundant electrical power, since approximately twelve kilowatt hours of electricity is required to produce one pound of metallic aluminum.[3] It has been said that the aluminum industry can not afford to use power costing more than $10 to $15 per horsepower-year. This figure rules out all fuel-fired power installations except under the most unusual circumstances. Furthermore, the industry must be located where the rainfall is

[3] At one cent per kilowatt hour the electrical energy alone would cost twelve cents of the twenty cents normally received per pound of aluminum.

abundant, where cheap land is available for reservoirs, and where there is a great drop in streams or water lines.

The dependence upon electrical energy is required by the nature of the mineral. Attempts to reduce the pure aluminum oxide (alumina) directly by smelting it with coke will not produce the metal because the temperature required is so high that the aluminum comes off as a vapor. Moreover, this vapor cannot be condensed as a metal by cooling because the aluminum oxidizes at lower temperatures and again becomes aluminum oxide—the material used in the beginning. The major technical problem involved was how to get the oxygen from the aluminum oxide without vaporizing the aluminum. The problem has been solved by dissolving alumina in molten cryolite and then running an electric current thru the solution.

Other factors considered in locating a reduction plant are proximity to the source of alumina and the proximity to fabrication plants. Where it is possible to find a bauxite field, a coal mine, and water power for reduction of the alumina into metal within a hundred miles or so, as in southern France, the freight problem is considerably simplified. It might be noted here that ten-thousand-eighty pounds of raw materials and accessorial freight must be moved to produce one thousand pounds of metallic aluminum.

The four centers for reduction plants in the United States are: (1) Alcoa, Tennessee, where power is secured by a series of hydroelectric developments on the Little Tennessee River with large reservoirs in the Great Smoky Mountains, (2) Badin, North Carolina, where the Yadkin River is harnessed, (3) Massena, New York, where the current of the St. Lawrence River is converted into electrical energy, and (4) at Niagara Falls with its hydroelectrical developments.

Raw Materials Used in Reduction

As stated above, aluminum is made by running an electric current thru a solution of alumina and molten cryolite. For this latter basic raw material the aluminum industry had to go to Greenland where the only commercial deposit of cryolite is found. Small deposits have been located at Miask in the Ural Mountains and on Pikes Peak in the United States but these are of little or no importance. Cryolite received its name from a Greek word which means "ice stone," since the mineral so closely resembles ice in

Fig. 3. The village of Ivigtut, Greenland, is located on the bleak shore of Arsuk Fiord. The cryolite mine is in the center of the village. (Courtesy of Pennsylvania Salt Company)

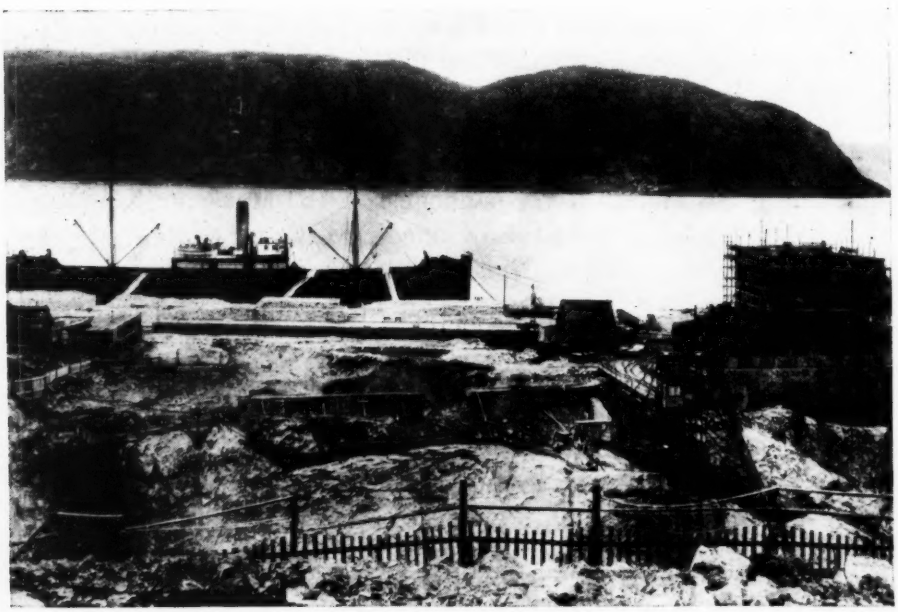

Fig. 4. Loading cryolite at Ivigtut. The open pit mine is just beyond the fence in the foreground. (Courtesy of Pennsylvania Salt Company)

appearance. The Greenland deposit lies on the shore of Arsuk Fiord at the village of Ivigtut (Fig. 3). The mineral is mined from a large open pit along the side of the fiord (Fig. 4). The mine is owned by the Danish Government altho a Philadelphia company is the agent for North America and has a purifying plant located at Natrona, Pennsylvania, near Pittsburgh. Recent technical discoveries have made it possible now to produce synthetic cryolite which may be used in the electrical reduction of aluminum.

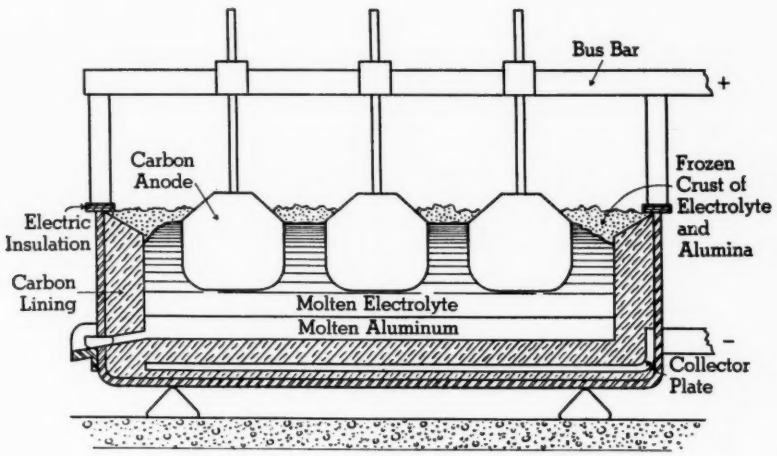

Fig. 5. A diagram representing a pot. When the molten cryolite comes in contact with the air it solidifies or forms a "frozen crust." This helps hold in the heat. The new alumina to be used is placed on this crust and is preheated before it is introduced into the solution. The molten aluminum is drawn off at the lower left end of the pot. (Courtesy of Aluminum Company of America)

Since molten cryolite attacks practically all metals, including steel, a carbon lining must be provided for the steel-shelled containers or "pots" in which the aluminum is reduced (Fig. 5). The electric current is introduced into the solution by means of carbon anodes which are consumed in the reduction process.[4] Next to alumina, carbon anodes are the most important material consumed. Since all of the impurities of the consumed carbon go into the metallic aluminum, the importance of purity is apparent. The highest grade of low-ash petroleum coke is mixed with carefully chosen portions of pitch and tar and pressed into desired shapes. About

[4] As the electric current goes thru the solution the oxygen of the aluminum oxide (alumina) unites with the carbon of the anode to make carbon monoxide and carbon dioxide which escape.

three-fourths of a pound of carbon anode is consumed for each pound of aluminum produced.

As the electric current passes thru the solution the molten aluminum is deposited on the carbon bottom of the pot and about every two days it is tapped into large mixing ladles from which it is cast into pigs. Since the cryolite is not affected by this process, alumina is added from time to time and the process is continuous.

The metal, as it comes from the pot, contains some dross and the impurities from the consumed carbon anodes. These impurities are removed by remelting the metal and casting it in the form of ingots. If alloys are desired, the alloying takes place during the remelting operation. The development of strong, wrought alloys of aluminum in the United States came almost entirely after 1920. The alloying material used is determined by the property desired in the metal. When strength is desired, copper is added; for resistance to corrosion, manganese; for polish and decoration, nickel or silver; for wearing resistance, silicon; and for cheapness, zinc.

Fabrication

The plants which use the crude aluminum in the fabrication of various aluminum products are widely distributed and vary greatly in size. Since fabricated products are usually bulky they are generally manufactured near the consuming centers. There are, however, other factors to be considered. Adequate railroad facilities for transporting both raw materials and manufactured products, an economical supply of fuel and power, a suitable labor supply, and large quantities of industrial water are important considerations. These factors are well illustrated in the location of the large fabrication plant at New Kensington, Pennsylvania, which is a part of Greater Pittsburgh.

Foreign Producing Regions

The most important competitor of the United States in aluminum production is Germany.[5] This is somewhat surprising since the Germans must import almost all of the bauxite. However, since seventy-five per cent of the aluminum output comes from three state-owned plants it may be inferred that the industry has grown

[5] In 1938 the six leading producers of aluminum were (1) Germany, (2) United States, (3) Canada, (4) U.S.S.R., (5) France, and (6) Norway. Production in Germany and the United States was almost the same but each produced three times as much as Canada, their nearest competitor.

under the pressure of the armament program. This idea is further verified by the fact that coal-steam power supplies most of the electric current for the reduction of the aluminum. It is true, however, that the large deposits of brown coal can be mined at low cost since they are very near the surface. The imports of bauxite come chiefly from Hungary, Yugoslavia, and Italy, where German controlled companies produce the ore. Another important source of bauxite is from the Dutch East Indies. In fact, eighty per cent of the ore from this part of the world finds a market in Germany. Prior to 1935 the chief source of Germany's bauxite was from France but in that year the French Government issued a decree prohibiting the export of the ore. Immediately the German Government bought large clay deposits in Saxony which may be used in the aluminum industry in the case of an emergency. However, as long as the Germans remain friendly with Hungary there is little danger that such an emergency will arise, since the largest bauxite reserve in all Europe is in Hungary, southwest of Budapest.

As in the case of Germany, in the U.S.S.R. the aluminum industry is due to government self-sufficiency program and not to economic raw material resources. While there are eighteen localities on the eastern slopes of the Urals where bauxite occurs, the problem of the long haul must be considered since the present reduction plants are on the western side of Russia.[6]

In striking contrast to the long hauls of Russia, France is very fortunate in having large quantities of high grade bauxite, coal, and an abundance of water power in close juxtaposition. The aluminum industry is concentrated on the eastern side of the Rhone River near the Italian-Swiss-French boundary. For a long time France supplied most of the world with bauxite. However, the exportation of the ore, alumina, and aluminum from France is now controlled by the government.

The importance of water power in the normal development of the aluminum industry is emphasized by the fact that the oldest aluminum company in Europe was founded at Neuhausen, Switzerland, altho the country is without a commercial bauxite deposit. Similarly, Norway, with an abundance of hydroelectric energy near the sea, manufactures large quantities of aluminum but depends upon imported ores and the export of crude aluminum.

[6] One is located near Leningrad on the Volkhor River, a second near Dnepropetrovsk on the Dnieper River, and the third at Kamensk on the edge of the Donetz Coal Basin.

Despite its absence of bauxite Norway ranks sixth in the world's production. Most of the metal is shipped to the United States and Germany.

Italy is another important producer of aluminum in southern Europe. It depends upon bauxite mined in the Istrian Peninsula and the water power developed in the nearby Alps.

The only important development in the Orient is in Japan. Lacking bauxite deposits of its own, Japan depends upon ore from the East Indies and from the mandate islands of Pelew, Penape, and Yap. Long dependent on foreign sources for aluminum, the Japanese began the industry in 1933 behind a high tariff wall. The actual production as yet is small but a very ambitious program has been planned including the use of the large coal reserves of Manchukuo for both heat and power.

Altho large reserves of bauxite probably exist in the equatorial regions and in the southern hemisphere, as yet the countries south of the equator have entered the field of aluminum production on a very, very small scale.

CONCLUSION

The rise of the aluminum industry following the Hall discovery in 1886 has been phenomenal. New uses are continually being found for aluminum and the industry is expanding rapidly. However, stainless steel and steel alloys are important competitors. The industry having developed in many places under the stimulus of government subsidies, diplomatic and military changes may in the future greatly modify the aluminum production of the world.

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FOURTH GRADE GEOGRAPHY TEST*

By Committee of National Council of Geography Teachers

A committee has been at work for the past several years upon a testing program for the National Council of Geography Teachers with a view toward publishing some tests. First we surveyed the geography tests which are now on the market. There are geography tests incorporated in batteries of achievement tests which consist of 75 to 100 items and sample large areas of knowledge. There are separate geography tests of several hundred items which also sample rather wide areas of knowledge, with norms established for the various grades. The committee did not think it advisable for the Council to parallel tests already available. Therefore, we turned our attention to the construction of detailed tests for comparatively narrow fields. The first test which is ready for publication is one prepared for the fourth grade. It was given a tryout, the results were analyzed statistically, the test was revised.

Our reasons for selecting the fourth grade for the initial venture are several. The fourth grade is the level at which the systematic study of geography is introduced. Considering that a child advances from one level of difficulty to another as he accomplishes geographic learning and that each level builds upon understandings mastered at previous levels, we believe we can best construct a series of tests by starting with the simplest geographic ideas and understandings.

We first set up what we expected to test by studying the objectives presented in the 32nd Yearbook of the National Society for the Study of Education, "Teaching of Geography" 1933, and by tabulating units in geography textbooks for the fourth grade. Nine of the current textbooks of the one-cycle plan are similar in viewpoint, that of building an initial framework thru the presentation of type studies of peoples, in strikingly contrasted natural environments, at different distances from the equator. We found seven units common to all nine textbooks: (1) primitive life in hot, wet lands, with the Congo or the Amazon as the setting; (2) life in hot dry lands in northern Africa or southwest Asia; (3) farmers in the Mediterranean lands as a transition from the tropics to higher latitudes; (4) mountain people midway between the equator and the North Pole represented by Swiss herders; (5) lowland peoples

*The National Council of Geography's series of tests are being published by McKnight and McKnight, Bloomington, Illinois. All inquiries should be addressed to the publishers.—Editor.

faced by drainage problems exemplified by Dutch farmers on the delta of the Rhine; (6) fishermen or farmer-fishermen along a rock-bound indented coast in higher middle latitudes; and (7) tundra people (Eskimos, Laplanders) and polar explorers. These seven units make up the major portion of the fourth grade book in each of the nine series of geographies.

In the construction of the test we endeavored to measure geographic understandings and their component associations and relationships. We veered away from testing purely for retention of facts. We were concerned with the use of facts. We wished to discover the child's ability (1) to obtain facts from maps, pictures, and text material; (2) to select facts from his own storehouse that are pertinent to the problem in hand; and (3) to apply understandings previously mastered. In other words we are endeavoring to test his geographical-mindedness.

We constructed a test of 112 items and gave it a tryout in May, 1938. Participating in the tryout were twelve fourth grades in six different school systems in cities ranging in population from 4,000 to 154,000, located in one eastern state, one southern state, and two mid-western states. Papers of 327 fourth grade children were returned to us. A detailed study was made of these 327 cases and a summary of the results follows.

RELIABILITY

The reliability of the test was computed by finding the coefficient of correlation between the chance halves (odd numbered and even numbered items). The self correlation is 0.95. ("A coefficient between 0 and 1.00 implies some degree of positive association, the degree of association depending on size of the coefficient." Garrett, H. E.: *Statistics in Psychology and Education,* p. 151.)

RELATIVE VALUE OF TEST ITEMS

The preliminary form of the test was composed of 112 items. The present form of the test has been reduced to 92 items. The 18 items which were discarded were selected on the following bases:

1. Range of difficulty as determined by frequency of errors

If an item was missed by less than 10% of the children it was considered too easy. If an item was missed by more than 90% of the children, it was considered too difficult.

Number of items missed by fewer than 10% of the children	3
Number of items missed by 11-25% of the children	32
Number of items missed by 26-50% of the children	58
Number of items missed by 51-75% of the children	17
Number of items missed by 76-80% of the children	2
Number of items missed by 81-100% of the children	0
Total number of items	112

2. Discriminating power of the items

If an item did not attain at least a 15% differentiation between the highest fourth of the children and the lowest fourth, it was considered a poor test item.

Percentage of differentiation between highest ¼ and lowest ¼	No. of items
0-15%	5
16-30%	26
31-45%	39
46-60%	30
61-75%	12
Total	112

3. Comparison of the different types of items

The test was composed of items of the yes and no type, and of the multiple choice type. Almost half of the items in the original test were single-response items pertaining to the reading or interpretation of a paragraph, a picture, or a map. The chance element in the single-response item does not appear to run high in this test. This is evidenced by the discriminating power of these items as shown in the following table. The fact that the single response items are not testing memory but are testing the use of material provided in the test probably helps to reduce the chance hazard. The yes-no

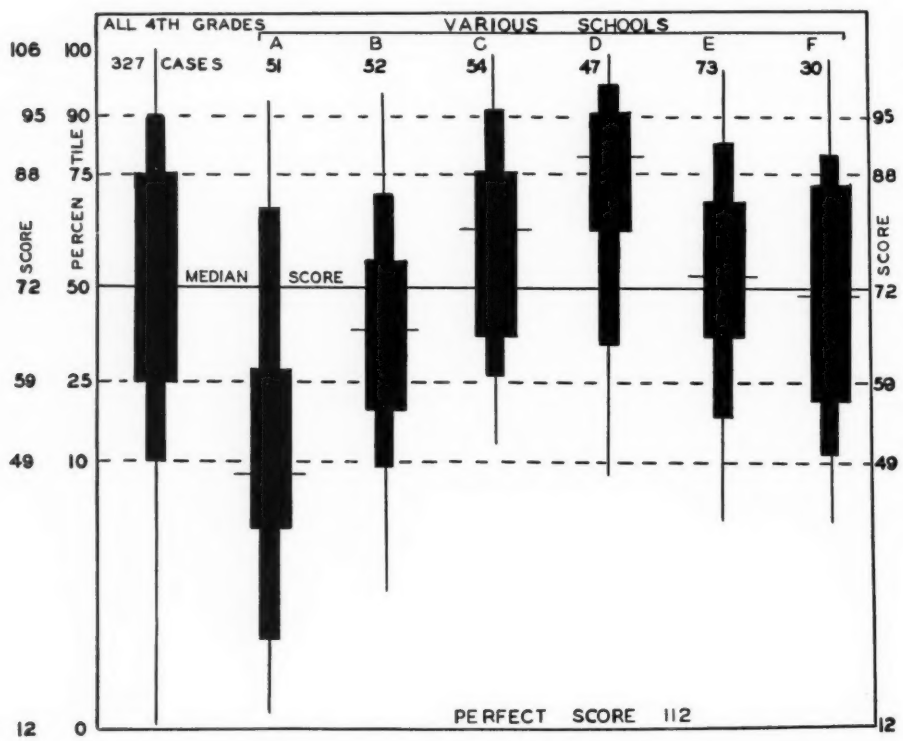
Type of item	No. of items	Average No. of the 327 children missing this type of item.	Average differentiation between highest fourth and lowest fourth of the children.
Yes-No	51	112	35%
Multiple choice			
3 choices	13	114	36%
4 choices	11	93	38%
5 choices	14	130	49%
7 choices	23	131	49%
Total test	112	116.9	36%

items are particularly well suited to the fourth grade child who is struggling with the mechanics of reading. It is true that these yes-no items do not attain the quality of the multiple choice items, but they do make possible a larger number of items in a thirty minute period of testing.

4. Time element
   58% of the children completed the test in 30 minutes
   30% of the children completed the test in 31 to 45 minutes
   12% of the children completed the test in more than 45 minutes

VARIABILITY OF ACHIEVEMENT

Tryout of 4th Grade Geography Test (May 23-27, 1938)



NOTE: The wide portion of each bar represents the range of scores of the middle half of the group of children. The narrow parts extend up to the 90th percentile and down to the 10th percentile. The lines at the ends extend up to the 100th percentile and down to the 0. The short cross line near the middle of each bar represents the median score of each group.

Variability of Achievement

The tryout of the test in six different school systems shows a wide range in the achievement of the different groups of children even tho the fourth graders selected for testing by the school administrators were considered to be average children. Group A rated the lowest of the six groups tested. The only information that the committee had about this group was that it did not use textbooks, but did follow the general fourth grade geography curriculum and used reference books. All the other five groups had textbooks. Since there are no data available on the many variables of instruction, such as quality of the teacher, time allotted to geography, reading ability of the children, general intelligence of the children, quality of pupil activities, quality and quantity of reference material; the standing of the non-textbook group versus the textbook groups is merely an observation and cannot be interpreted as a conclusive evidence of causes of the difference in achievement.

Marguerite Uttley,
Chairman of Testing Committee,
State Teachers College, Cedar Falls, Iowa

Composition of the committee

Preparation of the test
Zoe Thralls, University of Pittsburgh
Marguerite Uttley, Iowa State Teachers College

Statistician
J. B. Paul, Iowa State Teachers College

Consultant
Ernest Horn, State University of Iowa

Tryout
W. J. Berry, Western State Teachers College, Kalamazoo, Michigan
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George J. Miller, State Teachers College, Mankato, Minnesota
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Publication
George J. Miller, Editor of Journal of Geography

CONSERVATION OF OUR FUEL RESOURCES

A RADIO BROADCAST

GLENN G. BARTLE
Dean of the Faculty

SIDNEY E. EKBLAW
Chairman, Department of Geology and Geography

HENRY G. HILKEN
Instructor in Department of Economics, University of Kansas City

THE FOLLOWING is a radio broadcast given by three professors of the University of Kansas City over station WDAF. The round table discussion deals with one of our great natural resources. It sets forth interesting information for the use of classes in senior high school or junior high school.

Three members of the class seated at a table, each with an improvised microphone, may broadcast from their notes just as the professors did, and the class listen to the discussion just as the radio audience did.

The speakers should rehearse for fluent reading in advance of the broadcast. An announcer should also be at the table with well prepared introductory and closing remarks.

Occasional radio exercises of this nature may be given by a group of students before the class. Conservation of other natural resources might be the theme of additional broadcasts, or topics may be proposed for the next round table discussion.—EDITOR'S NOTE

HILKEN: We rarely realize that our whole economic system is dependent upon power, obtained from the three major mineral fuels—coal, oil, and natural gas. All our machinery and transportation facilities are operated by electricity, steam, and the internal combustion of oil and natural gas. The production of steam and electricity is in turn dependent upon these fuels, plus water-power generation. Hence, the conservation of fuels as energy resources is a fundamental problem of our society.

EKBLAW: This is, indeed, a fundamental problem because all the mineral fuels are considered exhaustible resources that can never be replaced; once used they have "gone up in smoke." This is in contrast to annual crops or forest resources which can be reproduced year after year. Even some of our mineral resources such as iron and copper can be reclaimed for a number of times without very much loss in quantity.

HILKEN: Before considering the possibilities of conservation of these mineral fuels, perhaps we'd better examine their various uses, and estimate which of these are most fundamental and necessary.

BARTLE: Obviously, if there were only a limited amount of oil,

it should be used as a lubricant. The maintenance of heavy machinery of the world depends upon lubrication by mineral oils. The second important use of oil is as fuel in internal combustion engines. Its efficiency here depends upon its use in small power units such as automobiles and tractors. Another use is for producing power. The most efficient device of this kind is the Diesel engine. Altho fuel oil is also used for heat in generating steam, this is distinctly not good conservation practice because heat is lost in changing from oil to steam and thence back from steam to power. The chief advantage of oil as a fuel is that it happens to be liquid and can be so easily handled with little labor. For instance, 70 per cent of American ships use oil.

Hilken: You would conclude, then, that the most necessary use for oil is as a lubricant; that its least desirable use is as a fuel for steam generation; and that its use in internal combustion engines is intermediate.

Ekblaw: Now, speaking about the second fuel, natural gas, its most apparent economic use is as a domestic fuel.

Hilken: Of course, the electric companies say that electricity is the best cooking fuel and I would like to point out that electricity is ordinarily produced from coal, as is artificial gas.

Ekblaw: True, perhaps, but the aeriform character of natural gas gives it a distinct advantage. It is introduced directly into the kitchen or basement furnace without any loss of energy. Whereas, electricity has to be transformed from coal, as you suggest, to an energy, and then converted back to heat. Neither natural gas nor electricity have any cost of handling after the initial installation expenses.

Hilken: What about gas as an industrial fuel?

Bartle: The chief reason natural gas competes with coal in the industrial plants is because there is a great supply of it available at present, and because it can be staggered with the residential load. It is common practice to dedicate the gas supply of a pipe line system to domestic use. At those hours of the day and in those seasons of the year when residential usage falls off, there is an overflow of gas available. This can be sold for industrial purposes at a cheap figure, thereby securing more nearly one hundred per cent utilization of the pipe line.

Hilken: But it does make a good industrial fuel, for example,

for glass factories, brick kilns, and for the baking of paint or enamel on automobiles and other metal objects.

Ekblaw: Sure, but in all of these cases the main advantage of natural gas is still its easy handling and its aeriform characteristics. Devices have been invented to permit the securing of higher temperatures with gas and compressed air than with gas alone. Gas can be used for power directly in a gas engine, as is done on an oil pumping lease. The use of gas as an indirect source of power is probably not defensible from a long time point of view. For instance, we find gas being used to fire boilers, which means that the energy is being transformed into steam and the steam transformed into power, certainly an uneconomic use. In addition, the present abundance of natural gas has encouraged the use of a greater quantity for making carbon black, which is a questionable fundamental and necessary use because we obtain a very cheap product at the expense of a great quantity of gas.

Hilken: Why do you question those last two uses of natural gas, Ekblaw? From the manufacturer's viewpoint, it may be the most practical low-cost fuel.

Ekblaw: That may be true for the individual manufacturer at current prices of natural gas. But we must consider its value fifty to one hundred years hence when it will likely be much more scarce and therefore more expensive. Then it will not be available for its most fundamental and necessary use, namely for cooking and home heating. Consequently, from a conservation viewpoint, it would be far better to substitute a fuel resource that has a much greater reserve, such as coal.

Bartle: Let's talk about coal, Mr. Hilken.

Hilken: Coal has been the standard fuel in America since the Civil War and from the Civil War to 1900 it was practically without competition. As a fuel the main advantages of coal are that it exists widely thruout the country, its wholesale distribution is relatively easy and flexible, and it is cheap when considering the capital equipment needed to convert it into heat energy. And finally, coal is cheap fundamentally in terms of the B. T. U.'s that can be obtained per dollar of fuel resources.

Bartle: Is there any possibility that coal can be made even cheaper?

Hilken: That depends on several things; increased mechaniza-

tion of mining, improved methods of recovery from mines that might have been abandoned, and utilization of lower grade coals that are near the surface.

BARTLE: In that connection, I want to emphasize the increased development of strip mining, which is entirely mechanized and permits one hundred per cent coal recovery.

HILKEN: Furthermore, coal will be made more attractive from a cost standpoint as stoking and feeding methods are improved. Coal will be a more economic fuel if the labor problem can be solved in such a way as to reduce labor costs per ton. But it should be remembered that the railroad's transportation charge is a large part of the wholesale price; consequently, unless railroad rates are reduced a sizable reduction in coal prices is unlikely.

EKBLAW: You paint a pretty picture of the coal situation, Mr. Hilken, but I want to remind you that there are also a number of disadvantages of its utilization. For instance the difficulty of igniting coal, and its dirtiness. It's the cause of the smoke nuisance that still plagues our cities after all these years.

HILKEN: However, modern stokers have greatly improved the domestic and industrial handling of coal. As for smoke, we already have inventions that will eliminate it almost entirely, if we will use them.

EKBLAW: In spite of all that, the use of coal requires the removal of ashes, which is certainly a greater inconvenience than using gas or oil.

HILKEN: Well, Ekblaw, that and the other inconveniences you've mentioned are pertinent. I will admit that if we had infinite reserves of oil and natural gas they would be the most desirable fuels. However, they are, even today, relatively scarce and in the future will be even more so. I maintain that coal is the cheapest fuel. Bartle, will you help us out by estimating the relative costs of these fuels?

BARTLE: A good grade of bituminous coal has about 28 million British thermal units of heat per ton. Figuring seven dollars per ton, the consumer gets about 4,000,000 B. T. U. per dollar. Natural gas has about 1,000,000 B. T. U. per 1000 cubic feet. At a cost of fifty cents per thousand, the return is 2,000,000 B. T. U. per dollar. At the current price of six and eight-tenths cents per gallon distillate produces the same B. T. U. per dollar as natural gas. Gas-oil is a little cheaper and fuel oil is approximately the same return as coal

per dollar, but it cannot ordinarily be used in a house-heating unit. But there's another side to the picture. Oil and gas are burned more efficiently and sparingly than coal, thereby reducing substantially the total cost to the householder.

HILKEN: Well, I want the last word here. For industrial heating and power where a bit of dirt and the convenience of living room thermostatic control are not so important, the cheapness of coal makes it America's No. 1 fuel.

EKBLAW: With respect to the long time view and problems of conservation, we had better consider current estimates of our known reserves of these fuels.

BARTLE: The best estimate of proven petroleum reserves of the United States is almost sixteen billion barrels. This seems like a large figure but we are actually withdrawing one and two-tenths billion barrels annually which means our known reserves will last about thirteen years. However, such a figure is not final because new fields are constantly being discovered. Improved methods of recovery and greater efficiency in refining and consumption will lengthen the life of these reserves.

HILKEN: How much gas is available?

EKBLAW: The annual production of gas was two and one-half trillion cubic feet in 1938, which is a jump of one trillion cubic feet in the last five years, and six times as much as in 1906. I might mention here that the reason for this enormous increase in the use of gas was the perfection of electric welding in pipeline construction which almost entirely eliminated leakage. Dr. Joseph Pogue recently estimated the proven reserves of natural gas to be in the neighborhood of sixty to seventy-five trillion cubic feet, or roughly twenty-five to thirty years' supply at the current rate of consumption.

HILKEN: In contrast to these short-lived resources, there are over three trillion tons of coal within three thousand feet of the surface in the United States. Coal was being used at the rate of about 700,000,000 tons per year at the time of the World War. It dropped to half that figure during the depression but has now increased to about 500,000,000 tons. Calculating consumption at the 700,000,000-ton figure, the reserve will last over four thousand years.

BARTLE: It will be observed from our own figures that there has been a tremendous increase in the use of oil and natural gas in the

last twenty years while the consumption of coal has not held up.

Hilken: These figures on reserves are in my opinion not much more than entertaining. As an economist, recognizing that use and recovery depends on price and cost, I think that any figure as to reserves or as to the number of years a resource will last must depend on the price and cost of that product and its substitutes.

Bartle: That is correct. These figures only show the order of magnitude of the various reserves and in summarizing them, oil would last 13 years, gas 30 years, and coal about 4000 years.

Ekblaw: Interestingly enough, we have a paradox in the oil and gas industry in that even the comparatively small reserves have temporarily flooded the market, giving us low prices. Every new oil strike has the possibility of causing the price to go even lower. Even the coal industry has been embarrassed by its extremely large reserves. The Federal Government has recognized this problem and the problem of waste, and there is every indication that regulations more far reaching than at present are in store for all the fuels. The National Resources Committee in its report of January, 1939, recommends greater control of these industries. While such a policy would help maintain the price structure it will require strict regulation of the industries as well as the control of opening of new mines or of new oil and gas fields. We may regret this interference with individual enterprise, but as citizens, interested in our future resources and in continued profitable operation of our industries, we must recognize that from long range point of view public control is a necessary policy.

Hilken: Can we expect any changes in these fuel industries in the next few years?

Bartle: The oil industry will undoubtedly continue to grow but at a somewhat slower rate than in the last few years. The number of automobiles and tractors is still increasing despite the oft-threatened saturation point. The consumption of gasoline may be reduced per unit of work as more efficient internal combustion engines are perfected. It is possible that we may be able to get still more gasoline out of each barrel of crude oil. Fuel oil is so attractive that it will continue to be used because of its convenience even tho it increases in price. The Navy, certain types of manufacturing, Diesel engines for railroads, small stationary engines, and even automobile motors will continue to use this fuel. But certainly, even with these changes, we should ever keep in mind the fact of our

thirteen years known supply of oil and that our most essential use of oil is for lubrication.

Ekblaw: And we have every reason to expect that the consumption of natural gas will continue to increase, particularly in the next few years. Pipe line facilities have only recently made natural gas available to many of our Midwestern cities, and they are not yet operating under full load. The large residential centers of the industrial east are additional potential markets for gas. But rather than for heavy industrial use, we should be more concerned with the conservation of this clean, convenient fuel for its most essential use, namely for the household.

Hilken: It is quite possible that the coal industry will overcome the disadvantages of handling and inconvenience. Already coal is being powdered and used in blowers essentially as a gas. Hydrogenation of coal, that is, mixing it with asphalt and hydrogen, changes it to a liquid and as such gives it the advantages of fuel oil. Ground coal and slack coal have been used for years, especially in Europe, in the form of brickets, contributing to cleanliness and ease of handling. However, all these processes which make coal more convenient to use, tend to increase its price to the consumer. The industry is faced with the dilemma of making its product more convenient at a higher price and putting it in competition with the other fuels or using it in the raw and retaining its present advantage, which is cheapness. Certainly, tho, with four thousand years' supply at the current rate of consumption, coal should be used in place of oil and gas for fuel and heavy power, leaving those two fuels available for a longer period of time for their more essential uses.

Ekblaw: Many students think that the day of direct use of coal is over and that coal will be used in some such processed form as we have indicated, or in the form of electricity. If coal is to be used as the source of electrical energy, from a conservation standpoint the generators should be located at the mines, thereby saving the energy and cost of railroad transportation. Experiments in Russia have even attempted to generate electricity by the combustion of coal underground, thereby eliminating the expense of hoisting coal to the surface. For city heat it is probable that the most efficient use of coal is thru central heating plants, selling steam to homes and office buildings on the basis of B. T. U. content and consumption.

RELIEF MODELING IN ELEMENTARY GEOGRAPHY

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The conceptions developed during the impressionable years of childhood are often times either a help or a hindrance in later academic study. If the initial image is fairly accurate it is a definite help, but if this first impression is not in keeping with realities the problem of altering the mental picture must be solved. This is possibly best realized in the field of geography in which a careful and accurate introduction may lead to an enjoyable and successful study. To this end relief modeling may prove to be a very worthy means in dealing with pupils as far down as sixth grade level. The following paragraphs describe a project of this kind worked out by a sixth grade class while making a study of the continents of South America and Africa.

The chief purpose of this project was to aid the students in formulating a correct conception of the land mass, as to shape and surface features, and to enable them to better interpret the influence these features have upon climate, industry, and centers of population. Previously, the students made a study of a hand-made relief model of their home town and surrounding community. In observing this they were interested in locating familiar places and in viewing those surface features which influence life in their home community. The study of the model was an inducement to them to build a similar one of the continent of South America, which they were beginning to study at that time.

Materials and Preparation

The students' interest in doing some modeling was thus aroused and they set about to find materials to use in the construction. In view of the fact that the project was to be personally financed it was necessary to find materials that were cheap and not too difficult to get. In this the class was indeed fortunate since in their home town is located a paper mill from which a "B" type corrugated box board was secured free of charge. This was obtained in pieces five feet by nine feet which served the needs very well. It is not to be understood that the construction of such models should be confined to this type of material only, because location, cost, and convenience might make it necessary to use other types of material.

A filler was needed to close up the perforations in the edges of the layers of corrugated board and to make the bevels or slopes. This was made, after considerable experimenting, with clays, paper pulp, etc. It was finally discovered that a home-made papier mâché served the purpose best. This was made by tearing newspapers into bits and putting them in just enough water to soak them well. About one and one-half gallons of this material was prepared and then placed over a hot plate and cooked. The cooking caused the paper to form into a fine pulp. It was then cooled and the water squeezed out, leaving the pulp moist but not with an excess of water. The pulp was then mixed with a flour paste. This paste was made by taking eight ounces or about two cups of flour and mixing with enough water to make a thin batter. Into this boiling water was poured, stirring constantly, until it was of a medium consistency. When this was cool enough the pulp was mixed with it and worked, by hand, until it was thoroly mingled.

The tools used in the work were small knives such as those used in airplane model construction, a pantograph, and a hypsometrical map. The various elevations on this map were shown in different colors which made it easier for pupils of this age to follow in transferring. These students were entirely unfamiliar with the use of a pantograph and also with the procedure necessary in relief modeling, so it was necessary to give plenty of instruction and demonstration. The map from which the outlines were to be transferred was prepared to the scale of 1:40,000,000 or 640 miles to the inch. The pantograph was adjusted to enlarge five times. This produced an outline map with horizontal measurements of 128 miles to the inch.

Construction Procedure

In order to acquaint the students with the use of the enlarging instrument the first layer or coastline of the continent was transferred for them. This layer was cut out by the students and given a good application of liquid paste, placed on the baseboard, and put under pressure. Each successive layer was traced on a new piece of corrugated board, cut out, pasted and put in place. When each layer was placed correctly it was then put under pressure until the adhesive material was dry. When thoroly dry each elevation was beveled along the edge with the aid of utility knives. The papier mâché was then applied to the slopes. This was done by hand taking care to work inland and upward in order to force the

filler into the perforated edges of the corrugated material. The mâché was brushed down well in order to leave a desirable surface, but more especially to form a binder over the edges. When thoroly dry this material forms a very satisfactory surface and one which is rigid and durable. It was then given five successive coats of liquid satinoid, which is a trade name for a special brand of flat wall paint. This type of paint was used in view of the fact that when dry it may be washed without material injury to the surface should the occasion demand. The paint was put on rather thick making sure to brush well as this aided in smoothing the slopes. The surrounding oceans and seas were covered with an ordinary blue paint.

The entire structure was then mounted on a frame which had been constructed by the boys of the class with the assistance of the janitor of the building. In making this frame those assisting received some experience in measuring and in the use of the miter box. During the entire period of construction there was no occasion when students were taken away from their regular academic study in order to complete the model. Their interest in the project was of such a nature as to urge them to work at recess and noon periods as well as occasionally after school. There were times when students were permitted to go to the work table, only, however, when it served as a reward for effort and achievement in academic work. The models were prepared in addition to their regular study and not in place of such.

EVALUATION

As the entire class approached the final steps of their study of the continent many interesting comments were made by different students. One twelve year old boy said, "It is easy for me to understand now why the Atacama Desert can be, when I see those high Andes Mountains and know the direction the wind usually blows." Another boy of the same age remarked, "I can understand the natural regions of the Plata basin much better by studying our model." When the model of Africa, which they built afterwards, was finished a girl of the class looking at it made this comment, "I always thought the land of the Sahara region was as flat as a board." An adult who was observing the finished models remarked, "I had no idea that the Andes of South America were so prominent or that the Southern part of Africa was such a highland area." These are only a few of the many comments offered. However, it is evident that the so called flatness or false picture of these

continents which had been interpreted by these people from former study of political and physical maps, had on this occasion been altered to some degree by these models in showing the real surface features.

The students of this class did not constitute a control group. Therefore, it is impossible to give definite information as to the actual benefits to be derived from this type of work. However, some general observations and comparisons of the results of work of former groups with that of this class, might have some bearing on the value and influence of modeling as a help in the study of geography. The study of the continent of South America constitutes the major part of the work for grade six during the first semester, according to the course of study set up in our county. The county tests given at the end of the first semesters during the past six years have been purely factual and have adhered very closely to the same items or facts. During these years some 225 students have been given the same work with varied methods of presentation. The 34 pupils of this class appeared in many ways to be only an average of the entire group, altho no measurement tests had been used to base this conclusion on. In their study they had what help the relief model offered them in understanding the continent more fully. On the term test, which followed, their average score was about 12 per cent above that of any previous group and about 20 per cent above the average of the five preceding years. These results, in addition to the value of the models in making geography a bit more real and in aiding individuals to avoid false conceptions, help to class this work as profitable to the students for whom it was planned.

ADDITIONAL COLLEGE-LEVEL EXERCISES IN CLIMATOLOGY*

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Some time ago a series of climatological exercises by the author was published in the JOURNAL. The following material presents additional exercises of a similar nature. The *unique* characteristics of both the preceding as well as the present exercises are thought to be: (1) the *specific* nature of the procedure to be followed, and (2) the *definite* character of the questions to be answered. This is in contrast to the vague generalizations so frequently found in similar laboratory exercises.

The exercises in this series deal exclusively with the explanation of the actual areal and seasonal distribution of precipitation in certain parts of the world. The *general* rainfall characteristics of any region are largely dependent upon air movements, either horizontal or vertical. The various planetary wind belts, the monsoon winds, "lows" and "highs," and other winds all play their part in determining: (1) where rainfall will occur, (2) how much will fall, (3) and at what time of the year it will fall. Hence, the following exercises attempt to explain the varying precipitation characteristics of different regions of the world in terms of the varying *prevailing* winds of those areas.

Other factors modify the rainfall regimes of regions. The most important of such disturbing elements are: (1) the size and character of the land surfaces involved (whether large or small, high or low, rugged or level), and (2) the presence of cold or warm ocean currents. These additional factors have not been introduced into the exercises, for the sake of simplicity. In those places where they *seriously* modify the expected rainfall characteristics of a region, their influence may be indicated to the students by the instructor.

RAINFALL AND THE PLANETARY WIND SYSTEM

I. Necessary Materials:

An atlas with copies of world rainfall maps, one for May to October and another for November to April (similar wall-maps can be substituted); two outline maps of the world; red pencil.

* For earlier climatological exercises of a similar nature by the author, see JOURNAL OF GEOGRAPHY, V. 38, 1939, pp. 233-238.

II. Introductory Note:

The relationship between rainfall and the planetary wind system is most apparent in the Southern Hemisphere, due to the fact that the monsoons of Asia and the "highs" and "lows" of North America and Europe throw the whole planetary wind system "out of balance" in the Northern Hemisphere. In the Southern Hemisphere, however, monsoonal tendencies are not so pronounced due to the smaller size of the continents, and the effects of "highs" and "lows" are confined mostly to latitudes where little land exists. Consequently, the relationships between the various planetary wind belts and rainfall are most apparent there. In order to show these relationships, follow the directions given below.

III. Exercise:

1. Refer to the atlas map of May to October rainfall. Copy the rainfall distribution shown on that map on one of your world outline maps. Copy *only* that portion between latitudes 15°N. and 60°S. Use the following color scheme: (a) solid red = 20 inches rainfall and over; (b) uncolored = under 20 inches rainfall. Label the map "Mean Winter Rainfall, Southern Hemisphere."
2. With lead pencil draw straight lines indicating the boundaries of the various planetary wind belts, according to the following data for July (draw boundaries only over oceans; *not* over continents):

Wind Belt	*Lat. Extent*
Equatorial Calms	15°N. to 5°S.
Southeast Trades	5°S. to 20°S.
Tropical Calms	20°S. to 30°S.
Westerlies	30°S. to 60°S.

(NOTE: These boundaries are only approximately correct. Each wind-belt gradually merges into the next adjacent one. Furthermore, the wind-belts are somewhat broken and modified in character as they alternately cross continents and oceans. However, the degree of modification in the Southern Hemisphere, with its relatively small land masses, is much less than in the Northern Hemisphere.)

Label each of these wind belts along the left-hand margin of the outline map.

3. Place symbols indicating the prevailing direction of air movement in the following locations, using arrows flying *with* the wind when the prevailing air movement is horizontal, using the symbol "U" when the prevailing air movement is up, and using the symbol "D" when the prevailing air movement is down.

(NOTE: Indicate wind directions that *should* prevail in the various wind belts. Actual wind directions sometimes differ from the ideal because of monsoonal tendencies, etc.)

a. in interior South America, at lat. 5°N., long. 60°W.
b. in interior Africa, at lat. 5°N., long. 15°E.
c. among the East Indies, in lat. 5°N., long. 120°E. (actually in monsoon area)
d. off the west coast of South America, between lats. 5°S. and 20°S.
e. off the east coast of South America, between lats. 5°S. and 20°S.
f. off the west coast of Africa, between lats. 5°S. and 20°S.
g. off the east coast of Madagascar, between lats. 5°S. and 20°S.
h. off the north coast of Australia, between lats. 5°S. and 20°S.
i. to the east of the East Indies, between lats. 5°S. and 20°S.
j. in interior South America, at lat. 25°S., long. 65°W.
k. in interior Africa, at lat. 25°S., long. 25°E.
l. in interior Australia, at lat. 25°S., long. 135°E.
m. off the west coast of South America, between lats. 35°S. and 45°S.
n. off the east coast of South America, between lats. 35°S. and 45°S.
o. south of the southernmost tip of Africa, between lats. 35°S. and 45°S.
p. off the southwest coast of Australia, between lats. 30°S. and 40°S.
q. off the west coast of the island of Tasmania, between lats. 35°S. and 45°S.
r. off the west coast of the islands of New Zealand, between lats. 35°S. and 45°S.

4. With the winter rainfall distribution of the Southern Hemisphere plotted, the approximate latitudinal extent of the planetary wind belts in that hemisphere located, and the direction of the prevailing wind movements graphically represented by symbols, *explain* the presence or absence of rainfall in *each* of the following areas:

   a. the *heavy* rainfall of most of South America, Africa, and the East Indies, between latitudes 15°N. and 5°S.
   b. the *sparse* rainfall in most of South America, Africa, and Australia between latitudes 5°S. and 20°S., *except* along the east coasts of continents and islands.
   c. the general *absence* of rainfall between latitudes 20°S. and 30°S. (those areas within this belt that *do* receive abundant rainfall cannot be explained by means of the planetary wind system).
   d. the heavy rainfall in the *western* portions of South America, Australia, and all of New Zealand, between latitudes 30°S. and 60°S., with *decreasing* amounts eastward.

5. Now take the second outline map of the world and, referring to the atlas map of November to April rainfall, copy the rainfall distribution shown on that map. Use the same color scheme as before, and copy *only* that portion between latitudes 5°N. and 60°S. Label this second map "Mean Summer Rainfall, Southern Hemisphere."
6. With lead pencil draw straight lines indicating the boundaries of the various planetary wind belts, according to the following data for January (draw boundaries only over oceans; *not* over continents):

Wind Belt	*Lat. Extent*
Equatorial Calms	5°N. to 15°S.
Southeast Trades	15°S. to 30°S.
Tropical Calms	30°S. to 40°S.
Westerlies	40°S. to 70°S.

(NOTE: these boundaries are also only approximately correct.) Label each of these wind belts along the left-hand margin of the outline map.

7. Use the same symbols to indicate wind movements on this map that were used on the preceding outline map. Place the symbols in the following locations:

a. in interior South America, at lat. 5°S., long. 60°W.
b. in interior Africa, at lat. 5°S., long. 25°E.
c. among the East Indies, at lat. 5°S., long. 120°E. (actually in monsoon area)
d. off the west coast of South America, between lats. 15°S. and 30°S.
e. off the east coast of South America, between lats. 15°S. and 30°S.
f. off the west coast of Africa, between lats. 15°S. and 30°S.
g. off the east coast of Africa and Madagascar, between lats. 15°S. and 30°S.
h. off the west coast of Australia, between lats. 15°S. and 30°S.
i. off the east coast of Australia, between lats. 15°S. and 30°S.
j. in interior South America, at lat. 35°S., long. 65°W.
k. south of southernmost Africa, at lat. 35°S., long. 25°E.
l. in southern Australia, at lat. 35°S., long. 135°E.
m. off the west coast of South America, between lats. 40°S. and 50°S.
n. off the east coast of South America, between lats. 40°S. and 50°S.
o. off the western coast of New Zealand, between lats. 40°S. and 50°S.

8. With the above data plotted on the "Summer" outline map, explain the presence or absence of rainfall in *each* of the following areas:

a. the *heavy* rainfall of most of South America, Africa, and the East Indies, between latitudes 5°N. and 15°S. (cold ocean currents largely explain the *lack* of rainfall along the west coasts of South America and Africa).
b. the *sparse* rainfall in the western portions of South America, Africa, and Australia between latitudes 15°S. and 30°S.; and the *heavy* rainfall of the eastern portions of those continents in those same latitudes. (Convection currents and monsoonal tendencies help explain the *deep interior* extension of rainy conditions during this season.)
c. the general *absence* of rainfall between latitudes 30°S. and 40°S. (Those areas within this belt that *do* receive abundant rainfall cannot be explained by means of the planetary wind system.)
d. the heavy rainfall in the *western* portion of South America, and in Tasmania and New Zealand, south of latitude 40°S., with decreasing amounts eastward.

9. *Describe* and *explain* the annual rainfall regime for each of the following regions, by comparing the Summer and Winter rainfall maps you have constructed. State whether the region is: (a) constantly wet, or (b) constantly dry, or (c) wet one season and dry another. If the last, state whether the rainy

season occurs during the winter or summer half-year. Name the wind belt that produces the rain and/or the drought of each region.

a. an east-west belt of land in Africa, between lats. 5°N. and 15°N. (except the easternmost part, which cannot be explained by means of the planetary winds).
b. an east-west belt of land in Africa, between lats. 5°N. and 5°S. (except the easternmost part).
c. that part of Africa lying southeast of the belt in ♯b., above (all but the *extreme* southeastern part).
d. the eastern portion of the island of Madagascar.
e. that part of northern South America between lats. 5°N. and 10°S. (except the western coastal region, south of the Equator, and a small portion of northeastern Brazil, both of which cannot be explained by means of the planetary winds).
f. the eastern coast of Brazil, from lat. 5°S. to 20°S.
g. that part of South America lying between 10°S. and 23½°S. (except the eastern and western coastal areas).
h. the west coast portion of South America, between lats. 0° and 30°S. (that portion between 0° and 15°S. cannot be explained on the basis of the planetary wind belts, but is due principally to the cold Humboldt Current).
i. the west coast portion of Africa, between lats. 5°S. and 30°S. (that portion between 5°S. and 15°S. cannot be explained on the basis of the planetary wind belts, but is due principally to the cold Benguella Current).
j. the northern and northeastern coastal portions of Australia, south to lat. 30°S.
k. interior Australia (i.e., all except the northern, eastern, and parts of the southern coastal margins).
l. the west coast of South America, between lats. 30°S. and 40°S.
m. the west coasts (not the south coast, however) of Australia, between lats. 30°S. and 40°S.
n. the west coast of South America, south of lat. 40°S.
o. all of New Zealand (note: these islands experience *moderate* rainfall even during the summer season—see Atlas rainfall map).
p. the east coast of South America, south of lat. 40°S.

(Note: the rainfall regimes of east-central South America, extreme southeastern Africa, and the southeastern coast of Australia are not explainable in terms of the planetary wind belts. Much of their rainfall is due to weak monsoonal tendencies and middle-latitude low-pressure areas.)

RAINFALL AND THE MONSOON WINDS OF ASIA

I. Necessary Materials:

An atlas with copies of rainfall and pressure-wind maps for Asia, one for May to October and another for November to April (similar wall-maps can be substituted); two outline maps of Asia; red pencil.

II. Introductory Note:

The monsoon winds radically disturb the planetary wind system over Asia. Consequently, the amount of rainfall received by the

various parts of that continent and the seasonal distribution of that rainfall are dependent *not* on the planetary winds, as was found to be the case in most of the Southern Hemisphere, but instead on the seasonal monsoon winds. To show the relationship that exists between the rainfall and the monsoons of Asia, follow the directions below.

III. Exercise:

1. Refer to the atlas rainfall map of Asia for May to October and copy the rainfall distribution on one of your outline maps. Copy only that portion south of latitude 50°N. Use the same color scheme mentioned in the preceding exercise.
2. Refer to the atlas isobaric map of Asia for July, and draw the 29.4 to 29.7 isobars shown on that map on your outline map. Using the atlas map as a guide, place arrows to indicate wind directions over Asia and the adjacent Indian and Pacific Oceans.
3. Draw a thick heavy pencil line north-south near the western coast of India, between latitudes 10°N. and 20°N., and another along the northern boundary of India. Let these lines represent mountain ranges.
4. Using the data you have plotted on your map, answer the following questions:
   a. why should a permanent low-pressure area exist over Asia during summer?
   b. in what direction are the July monsoon winds of Asia moving with reference to atmospheric pressure? with reference to land and water?
   c. *explain* the heavy rainfall of most of southern and eastern Asia during the summer half-year, on the basis of the data you have plotted.
   d. *explain* the sparse rainfall of interior Asia during the same season.
   e. explain the *abrupt* nature of the decline in rainfall, just to the north of India.
   f. explain the lack of *heavy* precipitation in the interior portion of the Indian peninsula.
   g. explain the sparse rainfall of Arabia, Persia, and northwestern India.
5. Refer to the atlas rainfall map of Asia for November to April and copy the rainfall distribution on the second of your outline maps. Do *not* use the same color scheme as before. Color the map red for all areas receiving 10 inches of rainfall or over, and leave uncolored all those areas receiving less than 10 inches rainfall.
6. Refer to the atlas isobaric map of Asia for January, and draw the 30.0 to 30.5 isobars shown on that map on your outline map. Using the atlas map as a guide, place arrows to indicate

wind directions over Asia and the adjacent Indian and Pacific Oceans.

7. Using the data you have plotted on your map, answer the following questions:

   a. why should a high-pressure area exist over Asia during winter?
   b. in what direction are the January monsoon winds of Asia moving with reference to atmospheric pressure? with reference to land and water?
   c. *explain* the lack of heavy rainfall in most of Asia during the winter half-year, on the basis of the data you have plotted.
   d. *explain* the presence of moderate precipitation in the following parts of Asia during the winter, when theoretically winter is the dry season in that continent: (1) Japan, (2) southeastern Korea, (3) east coast of French Indo-China, (4) southeastern India and Ceylon.

CONCLUSIONS

The climatological data involved in the above exercises are concisely stated in almost any good text on general college geography. Their memorization by the student from such a source is relatively easy but equally useless. It is only by working with and handling the materials in question that the student truly gains an *understanding* of them. It is felt that these exercises will provide the necessary familiarity with the materials.

However, it should be remembered that these exercises are only general in character. Many features of rainfall distribution and seasonal occurrence are not explainable in simple terms. Consequently the following points should be kept in mind by the instructor, since they will help to explain certain apparently anomalous precipitation features in the preceding exercises:

1. All areas left unshaded in the preceding maps (i.e., those receiving less than 20 inches rainfall for the half-year) are *not* arid. Many sections receive from 10 to 20 inches for the period and are distinctly humid.
2. Monsoonal tendencies, middle-latitude "lows," weak tropical "lows," tropical cyclones, cold ocean currents, and other factors help explain rainfall in certain areas where, according to the idealized planetary wind scheme or the simple Asiatic monsoon scheme, rain should not occur.
3. The straight boundary lines between planetary wind belts postulated in the preceding exercises do not exist. Actual boundaries between the various belts are highly irregular and fluid, while the belts themselves are broken in places and intensified in others by continents and oceans.

CENSUS OF GEOGRAPHERS

The Committee on Geographic Research of the Division of Geology and Geography in the National Research Council has undertaken a survey of the personnel of professional geographers in the United States for use in case of national emergency. A questionnaire was sent to all the members of the Association of American Geographers, and extra forms were sent to the heads of large university departments with the request that graduate students and other members of the staff not members of the Association be asked to fill them out. In addition the graduates of institutions granting advanced degrees, where present addresses could be found, were sent copies of the questionnaire. Query was made regarding fields of special competence.

It is especially requested that *any* professional geographers—persons active in geographical research—who have not received copies of this questionnaire, or who have not yet returned their copies, should immediately correspond with the chairman of the committee, Professor Preston E. James, Division of Geology and Geography, National Research Council, 2101 Constitution Avenue, Washington, D.C.

SPECIAL NOTICE FOR THE NATIONAL COUNCIL MEETING

Since there are practically no hotel accommodations available in southern Louisiana during the holiday seasons, reservations for rooms during the National Council Meeting at the University of Louisiana, December 27-28, must be made at once. Excellent dormitory rooms and meals are available at the University but the University does not supply bedding and linen. The local committee, headed by Dr. Richard J. Russell, is making arrangements to rent bedding and linen from a Chicago supply house, for all those who do not desire to furnish their own. To do this, he needs the following information at once:

Do you wish a room alone?
Do you wish a room with 2 or more single beds?
Do you intend to furnish your own bedding and linen?
Do you prefer to have the University furnish your bedding and linen at nominal cost?

Please send this information at once to Dr. Richard J. Russell, University of Louisiana, University, Louisiana.

Remember the field trip outlined in the September issue of the JOURNAL is scheduled to start from University at 7:00 A.M. December 29, under the direction of Dr. Chatterton, Southwestern Louisiana Institute, Lafayette, Louisiana. He is awaiting your reservation for this field trip which ends at New Orleans on December 31. You must get your own reservation for the night of December 31, as the University cannot accommodate you at this time.

Your promptness in making reservations for your stay, with or without bedding and linen, at University, and your reservation for the field trip is earnestly solicited.

CORA P. SLETTEN, *President*

EDITORIAL NOTES AND NEWS

The accompanying map presents the latest information available concerning the expansion of Russia. The incorporation of the three Baltic states, Lithuania, Latvia and Estonia, and the territories which formerly belonged to Rumania, that is, Bessarabia and northern Bukovina, was accomplished in the early part of August 1940. This constitutes the third stage of growth of the Soviet Union since the commencement of the war. The first two stages were, the incorporation of eastern Poland at the beginning of November, 1939, and the acquistion of Finnish territory by the treaty of Moscow on March 12, 1940. By these seizures of territory the Soviet Union has enlarged its area by about 176,000 square miles and has added about 21,200,000 people to its total population. This gives the Soviet Union an area of approximately 8,353,000 square miles and a population of approximately 192,000,000. Northern Bukovina and the northern and southern parts of Bessarabia were attached, on August 2, to the Soviet Republic of the Ukraine. Central Bessarabia was attached to the Republic of Moldavia which was formerly a part of the Ukraine and which is now a constituent part of the Soviet Union. Lithuania on August 3, Latvia on August 5, and Estonia on August 6, 1940, were officially admitted to the Soviet Union as member states. The Soviet Union is now composed of sixteen federal republics: Russia, Ukraine, White Russia, Azerbaidjan, Armenia, Georgia, Turkmenistan, Uzbekistan, Tadjikistan, Kazakhstan, Kirghizia, Carelo-Finland, Moldavia, Lithuania, Latvia and Estonia. The areas and populations added to the Soviet Union since the fall of 1939, are approximately as follows:

Territories	*Area in square miles*	*Population*
From Poland	75,100	11,508,000
From Finland	15,800	2,000
From Rumania	18,900	3,650,000
Lithuania	23,000	2,879,000
Latvia	25,400	1,995,000
Estonia	18,300	1,126,000

Explanation of the map:

1. (dotted area)—Soviet Union in August 1939
2. (black area)—Territorial enlargement of the U.S.S.R. since September 1939
3. Western frontier of the Soviet Union in August 1940
4. Frontiers of the member states of the Soviet Union

The Baghdad Railway, about which we have heard so much for many years, is finally completed. The Irakian section was inaugurated July 15, 1940. The railway, under construction since 1903, originally with German capital, connected with the Anatolian line at Konya and reached Nisibin at the beginning of the World War. In the same period the Baghdad-Samarra section was finished. During the war the British completed the Basra-Baghdad portion and a little later the Samarra-Baidji line. Then, during the course of the two following decades only the short Syrian section, Nisibin-Tel Kotchek was constructed. It is only recently that the government of Iraq has arranged for the completion of the intermediate part of the line which was still missing.

By the creation of this railroad, which is 1500 miles long, a direct link by land is realized between Europe and the Persian Gulf, interrupted only by the Straits of the Bosphorus at Istanbul.

Of late years, and owing to the energetic construction of Turkish railways, a new main line thru Ankara has been connected to the Baghdad Railway, as well as several branch lines to the Turkish ports. Since the end of 1939 the railway has also been linked by Erzerum with the Caucasian Soviet Republics and with Iran. On the other hand, communication has been established with Egypt by the Hedjaz line which has a junction at Alep.

Explanation of signs:

1—Baghdad Railway and connecting lines to Europe

2—Other railways

Louise W. Mears, for many years a teacher of geography in the Milwaukee, Wisconsin, State Teachers College, is the founder of a gold medal geographic award, conferred each year upon students whose theses on local geography rank highest. In June, 1940, at the Peru, Nebraska, State College, Russell Sommers was the fifth student to receive the Louise Mears Geographical Award. His thesis was on "Geographic Conservation in Nemeha County." John J. Brula received a similar award at the Moorhead, Minnesota State Teachers College for his thesis "Some Phases of the Geography of Clay County." The Louise Mears Geographical Medal Award is also offered at the University of Nebraska, at which institution the donor received her master's degree. Copies of the theses are placed in the college and local libraries.

GEOGRAPHICAL PUBLICATIONS

Paul H. Landis. **Three Iron Mining Towns, A Study in Cultural Change.** 148 pp. Edwards Bros., Inc., Ann Arbor, Mich. 1935. $1.75

The three towns whose cultural developments are studied are Hibbing, Eveleth, and Virginia, on the Mesabi Range, Minnesota. The study analyzes the natural resources of the Range, and the sequence in which they were developed. The findings reveal distinctive population cycles and patterns during the forty years in which Range towns have been developed. The first of these is called the pioneer period, ending between 1905-1910 with the social and cultural characteristics of the frontier. The present or extravagance period has a society more like those of any present-day city, and is, for its size, unrivaled in its public buildings, athletic and recreational programs. Is the third period to come to be one of decay?

CORA P. SLETTEN

Bibliography of the Island of Guam. Edited by Charles F. Reid. 102 pp. The H. W. Wilson Co., N.Y. 1939. $1.50

Realizing that most people of the United States know nothing concerning Guam, the Works Project Administration for New York City was solicited for the purpose of compiling an annotated bibliography on Guam. The Project is preparing similar bibliographies on the other Territories and Outlying Possessions of the United States. This volume reflects painstaking research involving examination of books, periodicals, documentary and manuscript sources. The editor is an authority on American possessions and is on the Staff of the College of the City of New York.

CORA P. SLETTEN

A. K. Lobeck. **Geomorphology, An Introduction to the Study of Landscapes.** 731 pp., 470 pictures and illustrations. McGraw-Hill Book Company, New York, 1939. $4.50

Geomorphology, by A. K. Lobeck, is one of the outstanding textbook contributions to appear in recent years. The artistic skill of the author and his rare ability to organize material for teaching purposes have resulted in a definitely superior product. Many geographers and geologists should find the volume extremely valuable as a basic text for introductory courses in their respective fields.

The logical order in which the different topics are treated is one of the book's best qualities. The text is divided into many small units of study, each one devoted to some important physiographic or geomorphic process. At the end of each chapter are several review questions, topics for investigation, and a selected bibliography. These are of value to the instructor as well as to the student.

Charts, sketches, maps, and diagrams are so carefully arranged that relevant text material appears on the same page or the page opposite the appropriate illustration. A generous number of striking bleed-off photographs, located at the beginning of each chapter, supplement the illustrative material distributed thru the text. It is to be hoped that more authors and publishers of textbooks will follow the example of Dr. Lobeck and the McGraw-Hill Book Company and take advantage of the visual aids which are so essential to successful teaching.

WALLACE W. ATWOOD, JR.

Clark University